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AUTHOR	Rillo, Thomas J.
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ABSTRACT

Information about hand lenses and their use in the classroom and out-of-doors for curriculum enrichment is presented in this paper. Some basic attributes of the hand lens, including shape, focal length, and magnification power, are described. Directions for making holders for the lenses in the classroom are given. Two classroom activities and 14 activities which may be carried out on school grounds are suggested as representative of the many kinds of observations that can be made with a hand lens. It was noted that, to the classroom teacher, the world of the hand lens can open up unlimited opportunities for curriculum enrichment. (PS)

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EXPLORING THE OUTDOOR CLASSROOM WITH A HAND LENS

by
Dr. Thomas J. Rillo
Professor of Conservation and Outdoor Education

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The world of the hand lens is a world little explored by the hurried masses of our population. Many are sometimes even insensitive to the larger world around them. This, in a sense, represents an inheritance whereby man lived on the earth unaware of what existed in a realm so small that he could not perceive it with the naked eye. He could only study and reflect on what was visible to him.

Somewhere in his development, man discovered the process of making glass. Perhaps some accident caused him to produce a curved piece of glass. When he peered through it, man discovered that objects were enlarged and hence magnification was discovered. This curved piece of glass eventually evolved into what we refer to today as a lens. Eyeglasses are fashioned from these lenses and enable individuals to see clearly the phenomena of the world about them. These lenses were utilized in telescopes, microscopes, and other opticals designed to look at the faraway stars and planets or to carefully scrutinize microscopic plants and animals. Through the use of this piece of curved glass, which we know as a lens, countless things can be observed, monitored, and otherwise studied that we never dreamed existed.

To the classroom teacher, the world of the hand lens can open up unlimited opportunities for curriculum enrichment. This lens, which is sometimes called a looking glass, a reading glass, or a magnifying glass, can be accessible to most school situations with limited budgets. A simple magnifier is one of the commonest and most useful of all the optical devices available to school situations. A homemade or classroom made hand lens, because of its inexpensiveness, will make it possible for every student to have one for his exploratory excursions both indoors and out-of-doors. A hand lens for every student will also insure involvement by all and will lessen any anticipated disciplinary problems because of the informality and less restrictive boundaries of the outdoor classroom.

The most useful lenses are those glasses of 3- to 10-power. The best lens to use as a hand held one is the double convex lens because it is symmetrical and can be used from either side. A plano-convex lens where one side is flat and the other convex may be used, however. When viewing an object, the convex side must face the object. The equal curves of the double convex lens has proven to be the best lens for students at all grade levels.

An interesting mathematics activity before making the hand lens is to figure out what power would be most useful to the class in light of what they are going to be viewing. A lens will refract or bend light rays, and any positive lens will refract parallel rays to a given point. The distance necessary to bring these parallel rays to focus is the focal length (F.L.) of the lens. In order to find the focal length of the lens, move it up or down on a regular school ruler until the light appears as the smallest dot on the surface of the desk or table. The students should be cautioned not to hold it in this position too long for it is the same technique utilized to start a fire with a magnifying glass. If the sun is not shining, a desk lamp or any lamp might be substituted as the source of light.

The distance measured on the ruler is measured to the center of the lens and becomes the focal length. A light bulb can be used in testing a lens focal length

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when the lens is under 5 inches.

Most lenses used as pocket magnifiers are of short focal length with small diameter and sharply curved surfaces. In the double convex lens the focal length is equal to the radius and with the flat surface of the plano-convex the focal length is equal to two radii.

The focal length is important even in the pocket magnifier because it will enable the teacher to select the power which can best be used by the grade level involved. Various sources have indicated that 10 inches is about as close as one can get to an object with comfortable vision. If 10 inches is assumed to be normal vision, then an object 1 inch from the eye would be 10 times closer and 10 times bigger if it could be seen. The hand lens enables one to view the object otherwise difficult to view. A one inch lens enables the object to be viewed up to one inch from the eye and the object is seen ten times larger than when viewed without the hand lens. The lens is then rated at 10X or ten power. A simple procedure for finding the power of a lens is to divide the focal length into 10 inches. Magnifying power is commonly referred to as 10 inches divided by the focal length. In essence, there are two basic concepts inherent in this exercise. One, that focal length can be determined, and two, magnification power can be determined and expressed.

After one of the lenses is selected, the next step is to fashion some type of holder for the lens. There are a variety of ways to mount the lens in order to secure it. The easiest method is to have three thin rectangular pieces of wood. Cut a hole in the middle piece of wood so that the lens fits snugly. The outer pieces of wood have smaller holes cut into them in order to hold the lens in place. The three pieces can be glued or screwed together. The outcome is a lens mounted in wood. A string can be attached to a small hole drilled into one of the corners. An alternate method is to cut a hole just big enough for the lens but not all the way through. Then cut a smaller hole from the other side until an opening is made. The shoulders provide a retaining ring for the lens. Place a second piece of wood with a hole cut to the smaller dimension of the opening. This provides retaining walls for the other side. Glue or use screws, or both, to hold these pieces together.

Heavy cardboard, leather, or masonite could be used in both methods of mounting the lens. There are other methods used to hold lenses in place and other types of materials. However, they would prove too difficult to be constructed on a school desk or a workbench and would eliminate student involvement.

Once the hand lenses are completed, the next task is to plan how they will be used as part of the school curriculum extended beyond the four walls of the classroom.

ACTIVITIES WITH THE HAND LENS

The following activities are suggestive of the many kinds of observations that can be made with a hand lens.

Classroom

1. Examine various objects in the classroom such as: cover of textbooks, fabric of clothes, piece of writing paper or glossy paper from a magazine, blotting paper, lead pencil writing on paper, leaves and stems of classroom plants, paint on

walls, chalkboard surfaces, human hair (curly, straight, blonde, brunette), human skin (top of hand contrasted to palm), fingernail and tips, and the human eye.
(Compare the texture of material--observe fibers and count the number of threads.)

2. Have the students bring in material from home, such as coffee grounds, sugar, tobacco, tea leaves, dust, soil from garden or shrub beds, etc.

School Grounds

1. Examine seeds of various plants. Observe their shape; some will be globular or oval in shape, some will be very thin and flat or smooth, wrinkled, pitted or angled or furrowed. Some seeds will be twisted or coiled, some will be covered with hairs or will have broad or membrane-like wings to enable them to be airborne. Observe the color and size of the seeds. See if students can find an embryo plant in the seed. Persimmon seeds are an excellent example of a pronounced embryo plant. A seed clue chart could be an excellent device to use with a hand lens. Size, shape, color, locomotion, covering, and other characteristics could be included.

2. Examine parts of insects found on school grounds with a hand lens. Observe the legs, three body regions, the feelers, the compound eyes, the wings, etc. An insect clue chart could be utilized with this activity. Size, shape, color, number of legs, number of wings, locomotion, surroundings could be included as physical characteristics to be observed.

3. Examine bird feathers found on the school grounds. Look at the shaft, the opening of the quill, the quill itself, the barbs and the veins. Examine the barbules which are innumerable little branches that interlock with the barbules of adjoining barbs. If the hand lens is powerful enough, the students can observe the barbicels and hooklets which comprise the interlocking device.

4. Examine parts of a flower with a hand lens. Look at the sepals, the petals, the ovary, the style, the stigma, the anther, and the filament. The pistil will consist of the stalk called a style, and the stigma at its tip. Look for pollen grains on the anther. Examine the crossection of an ovary and not the round bodies within which are located the egg. A flower clue chart consisting of such physical characteristics, such as sepals, petals, stamen (anther and filament), pistil (stigma, style, and ovary), receptacle, and location can be utilized.

5. Examine the hitch-hiking seeds. Observe the structures that catch in the fur of animals or in the clothing of man. Look for hooks, hook prickles, bristles, needles, etc. A burlap bag with holes cut for the head and arms can be worn by the students as they move through fields and meadows to collect hitch-hiking seeds.

6. Examine insect homes in the outdoor classroom. The shelters or dwellings which are more correctly called cases can be dissected with a knife and observed with the hand lens. Examples of these are the case of the bagworm, case of the maple leaf cutter, golden rod gall of the gall wasp, etc. In many cases the larvae stage of insect development may be observed. Insect homes can be found hanging from twigs, on the twigs, on leaves, on the trunks of various trees and shrubs. Compare texture and composition of one insect home to another type of

insect home. Compare color, size, shape or larvae found. This is an excellent wintertime activity and will enable a class to explore afield during a time when nature seems to be dormant.

7. Examine various rock particles with a hand lens. An examination of ordinary table salt in the classroom can serve as an introduction to the study of minerals before moving outdoors. Compare the shapes of rock and mineral particles found. The students can devise a rock and mineral clue chart including such things as texture, color, fabric, cleavage, shape, etc,, or predominant physical characteristics.

8. Examine leaf scars of trees during the wintertime. Leaf scars are excellent diagnostic characteristics. These smooth, light-colored areas appear as scars when you just look at them. There are indeed scars and are formed when the leaves fall off. Hand lenses can be used to determine the basic shape or outline of the leaf scar. Students can look closer and observe small raised dots. These dots are known as bundle scars, and they are the ends of the vessels which carried water in and out of the leaf. Some leaf scars are horseshoe shaped, some are U-shaped, others may be triangular in shape, or semicircular. The students can note the variations in the leaf scars of different trees and begin to learn to identify the trees. A leaf scar clue chart can be used with a hand lens and can include such physical characteristics as shape, size, number of bundle scars, color, placement on twig, such as opposite or alternate, level with twig, or raised to form an angle, etc.

9. Examine the buds of trees with a hand lens. Bud scales can be observed more closely with the lens and observations can be made as to whether they are covered with hair, waxy secretion, or whether there are scales at all. Some plants in more temperate zones are not protected by scales at all. Comparisons can be made of the terminal buds, the auxiliary buds, and the collateral buds. Sometimes there is a superposed bud. Sometimes there are buds that are formed anywhere on the stem except the leaf axils and tips, and they are called adventitious buds. Students can determine whether the bud scales are keeled, or have a ridge like the keel of a boat and that the margins are covered with fine hairs. Have the students lift the scales with a knife tip or pin and examine the scales with the hand lens. A tree bud clue chart could be utilized and could include sugh diagnostic characteristics such as size, shape, bud scales, position on twig, color, etc.

10. Examine ferns with the magnifying lens. Students can observe the fruit dots of the various ferns. Shapes of the fruit dots are interesting and they vary from one species of fern to another. Some are horseshoe-shaped, some are round, still others are kidney-shaped, slightly curved or oblong. Fruit dots are not always present on ferns since they are the reproductive structures and occur only at certain times. A fern clue chart could be utilized and could include such physical characteristics as size, shpe of frond, color, form, position, fruit dots, etc.

11. Examine insect eaten leaves. There is a wonderful opportunity to demonstrate that insects eat leaves and grow to maturity. Many insects are so small that they are not visible to the naked eye. The hand lens can magnify the tunnels or passageways that larvae of certain insects leave as they eat their way to maturity. Students will note that the tunnel gets wider as insect larvae grow larger. The beginning of the passageway or tunnel is a minute point and usually indicates where the egg was hatched. Sometimes each species makes its own

characteristic design.

12. Examine lichens, if available, for they do not thrive well in cities because they are vulnerable to air pollution. However, they are found everywhere conditions of life are not heavily saturated with gases and smoke. A lichen is in reality two dissimilar plants, the alga and fungus living together in what is known as mutualism. The hand lens can be very useful in a closer observation of this plant. There are many different kinds of lichens. Some grow on trees, others on rocks. Sometimes the fruiting structures can be compared and often the effect of the plants on the material on which they flourish can be examined. Look for the fruiting structures on lichens with the hand lens and compare to those of other types of lichens.

13. Examine the streets and other urban byways with a hand lens. Look at bricks, stucco, cement, asphalt, brown stone, grain of wooden doors, or window frames, the oxidation of metal, such as rusty nails, old signs, junked cars, railroad ties, railroad tracks, telephone poles, peeling paint. Compare these surfaces with those found in the more natural environment. Pollutant particles on leaves, rooftops, car surfaces, etc. can be discovered through the use of the hand lens.

14. There are many other observations which the classroom teacher migh have students make with the hand lens. Some of them are:

    a. Examining plant roots.

    b. Examining annual tree rings of a stump. Note summer wood and spring wood.

    c. Examining the water arterial system of a plant (bundles). Cut stem horizontally for this observation.

    d. Examining insect eggs, such as those found in spider sacs. Sacs are found hanging in webs, from trees, some are flat against stones or underneath leaves.

    e. Look at fish scales with the hand lens. Scales will be different in shape. Students can utilize a fish scale clue chart and include such diagnostic characteristics as bell-shaped, scallop-shaped, shield-shaped, round, oval, ribs, lines, rings, etc.

    f. Examine parts of soil under the lens. Sand particles, rock particles might be used as a comparison.

    g. Examine pollutant particles picked up on gauze attached to kites or weather balloons flown at different heights and distances from source of pollution, such as a burning garbage dump.

Sometimes the familiar is so obvious we walk by it without noticing. And yet it is this world that sustains our own continued existence through the countless interactions and interdependencies that are enacted. The above are only suggested activities and no doubt there are many more which are known and still others to be discovered. The use of the homemade hand lens can open this world to all students and thereby give them an opportunity to develop an awareness of the ecological

balance of the natural environment, which is a part of the community in which they live. It costs so little and it means so much for the future if stewardship for these resources is to be fully realized.

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